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Human Research Unit No. 3, OCAFF
Fort Benning, Georgia

Under the Technical Supervision of

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(2) LEVEL II

(1) Staff Memorandum

(6) The Mock Tower Rating System in the Airborne Training Program.

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(15) DA-44-188-ar-650

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Fort Benning, Georgia

(11) February 1954 (12) 27 p.

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The Mock Tower Rating System in the Airborne Training Program

Introduction

Prior to actual use of a parachute, Airborne trainees make a number of jumps from a 34-foot mock tower designed to simulate the conditions of free fall and riser shock. This training is intended to teach the proper method of exit from the plane door and the correct body position during free fall. In the course of study of methods to decrease the Airborne attrition rate in training, the mock tower phase of training has come under surveillance. In particular, this report is concerned with technical evaluation of the reliability and validity of the mock tower rating system, the primary measuring device used in corrective instruction and grading performance during this phase of training. The research was begun at Fort Benning, Georgia, by a Task Force of The Human Resources Research Office of the George Washington University, and completed by Human Research Unit No. 3, Office of the Chief of Army Field Forces.

The Mock Tower Training Procedure

The trainee wears a harness attached by risers to a trolley device which slides along a cable leading away from the tower. After taking the proper position in the door of the mock tower, and receiving a tap from the jumpmaster, the trainee jumps and falls "free" for about eight feet; the risers then arrest his fall and he rides the cable for about 75 yards to a dirt mound where he is unhooked from his harness by fellow students. He then reports to a rater for a critique of his jump. During the first week of training, the student

usually makes 12-20 jumps from the 34-foot mock tower. If the trainee makes a satisfactory jump, he continues to the second week of Airborne training; if he fails, he may be permanently disqualified or may repeat the first week of training, depending upon the types of errors made and his attitude.

The Rating Procedure

The rater, an Airborne instructor, observes the jump from a chair located 15 yards from the base of the tower. From this position, he can observe the performance from the time the trainee takes his position in the tower door until he has travelled approximately one-quarter of the length of the cable away from the tower. The primary task of the rater is to record the particular errors he observes during the jump, using a list of 31 errors (see Table 1). If, however, five or more errors are made on a jump, a symbol is recorded and no attempt is made to note the exact number or types of errors. Therefore the data from routine training procedures which are available for study of the efficiency of the rating procedure are restricted in range to 0-5.

The rater is responsible for other tasks in addition to and concurrent with recording observed errors. He must inform the trainee of his errors, and assign and supervise "mound men" and "rope men" who, respectively, release the jumpers from the harnesses and return the riser and harness devices from the mound to the tower for the next jumper. These interferences may consume more than 50% of the rater's time in any mock tower training period.

TABLE 1

Symbols Used in Rating Performance from Mock Tower

Error Symbol	Meaning
SQ	Squat Out
FO	Fall Out
W	Weak Exit
HOT	Hands on Top of Reserve
HC	Hands Crossed
HCOT	Hands Crossed on Top of Reserve
AC	Arms Crossed
GRD	Grabbed Reserve in Door
KB	Knees Bent
FA	Feet Apart
HU	Head Up
EO	Elbows Out
DO	Dive Out
KO	Kick Out
SO	Step Out
RQ	Recover Too Quickly
BFD	Both Feet in Door
WFD	Wrong Foot in Door
T	Turn in Air
H	Hesitate
R	Reaction Poor
BW	Bent at Waist
BS	Body Straight
EC	Eyes Closed
LC	Late Count
WC	Wrong Count
FC	Fast Count
NC	No Count
CID	Count in Door
NT	No Tap
(X)	More than Four Errors

The Specific Problems to Be Investigated

The following questions were investigated in the evaluation of the jump rating system:

1. Are these ratings reliable in the sense that different raters will rank jumpers in essentially the same way in terms of number of errors made?

2. Are these error ratings valid in the sense that they predict success or failure in the training course?

3. How persistent are these various errors and at what rate are they eliminated?

The first two questions deal with the adequacy of a frequency count of errors as a measure of quality of performance. The third problem is designed to provide information on the nature of the process of learning to jump. The data should show where more emphasis is needed in correctional training; incidentally, this information should also reveal whether the instructor needs to use and know a 31-item list or whether the list can be shortened with little or no loss of coverage.

The procedures and findings in the study of these three questions will be described in turn.

Reliability

Ratings made on 239 Airborne trainees constituting an entire class going through the course in the fall of 1952 were used to determine how well raters agree on the number of errors made on a jump. The group was randomly divided into four platoons. A pair of raters assigned to each platoon made independent recordings in the standard

manner, and performed the usual concurrent tasks. These data were collected on the same individuals for five alternate jumps, namely, jumps 1, 3, 5, 7, and 9.*

Table 2 contains the product-moment correlations between the number of errors recorded for individual jumpers by pairs of raters. The average correlation expressing agreement between raters (and presumably, therefore, their accuracy) increases over trials from .63 to .83, with the largest increase from the first to third jump. These correlations are a measure of the extent to which raters would agree on the rank assigned to the persons they observed. The raters in each pair could differ consistently in the absolute number of errors recorded for each jumper, yet they would nevertheless agree in differentiating between good and bad jumpers. That this condition did obtain was shown by analysis of variance which revealed significant differences among raters in the mean number of errors recorded.** Table 3 presents the mean number of errors per subject observed by each rater, and the standard deviations.

Three factors may operate to cause improvement in rater agreement as trainees progress through training: (1) as trainees become better acquainted with the tower area tasks and require less supervision and instruction from the rater, more of the rater's attention

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*Due to attrition the group was reduced to 213 by the ninth jump. The loss of these men from the group (presumably those making the higher number of errors) probably causes a slight lowering of the reliability coefficients between observers.

**See Appendix A.

TABLE 2

Reliability Coefficients for Four Pairs of Raters on a Series of Mock Tower Jumps*

	Mock Tower Jump Number				
Paired Raters	1	3	5	7	9
A and B	.51	.86	.82	.81	.84
C and D	.63	.65	.82	.81	.85
E and F	.47	.72	.77	.84	.68
G and H	.82	.81	.86	.88	.90
Average Correlations	.63	.77	.82	.84	.83

*Each set of raters rated approximately 60 jumps on trial 1, 58 jumps on trial 3, 55 jumps on trial 5, 54 jumps on trial 7, and 53 jumps on trial 9. The number of trainees rated on successive jumps decreased due to attrition.

TABLE 3

Means and Standard Deviations of Error Ratings for Eight Raters on a Series of Mock Tower Jumps

Rater		Mock Tower Jump Number				
		1	3	5	7	9
A	M	3.9	3.6	2.8	2.6	1.9
	SD	1.3	1.6	1.8	1.7	1.7
B	M	4.4	3.8	3.4	3.0	2.6
	SD	1.2	1.6	1.7	1.9	2.1
C	M	3.9	2.7	2.2	1.9	1.5
	SD	1.4	1.7	1.7	1.8	1.7
D	M	4.3	3.3	2.5	1.9	1.4
	SD	1.1	1.7	1.7	1.9	1.7
E	M	4.1	3.6	2.2	1.7	1.1
	SD	0.9	1.5	1.6	1.4	1.1
F	M	4.6	3.7	2.5	1.7	1.4
	SD	0.9	1.6	1.5	1.4	1.4
G	M	4.4	3.3	2.5	2.1	1.9
	SD	1.0	1.6	1.5	1.7	1.8
H	M	4.5	3.1	2.2	2.3	2.0
	SD	1.0	1.6	1.7	1.8	1.9

may be devoted to evaluating jumps; (2) as trainee performance improves, the number of errors made on a given jump is likely to decease, thus making the rater's task simpler and accuracy more likely; and (3) the raters may expect fewer errors in later jumps, and hence only the most obvious errors would be recorded.

In general, inter-rater reliability in terms of errors was satisfactory for the type of scoring being used. The fact that raters may differ to a small but significant degree in absolute number of errors recorded for a given subject should serve as a precaution against using arbitrary cutting points, in terms of number of errors, as a pass-fail criterion. In the training situation as it now exists, however, this is not the practice and it is not likely that one rater fails an individual who might be passed by another, or vice versa, on this basis.

Data were also obtained from an "artificial" situation in which the raters had only to rate jumps from the mock tower, and were not required to perform the concurrent tasks thought to interfere with accuracy. Eight raters scored 106 first mock tower jumps. The average inter-correlations* among the raters was .78, in contrast to the mean of .63 for the first jump obtained in the standard rating situation reported above. The higher correlation suggests that a better system would result if other cadre were added to handle the assignment tasks, leaving the rater to observe, record, and inform trainees of their errors. Significant differences were again found among raters in mean number of errors observed.**

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* See Appendix B.

** See Appendix C.

Validity

To determine whether the number of errors made early in mock tower training predicted success or failure in the Airborne course, the mock tower performance records of four classes going through Airborne training during the fall of 1952 were studied. The success group consisted of trainees who completed the course and graduated with the class in which they had originally started training. The fail group consisted of trainees who had been permanently disqualified from Airborne training.*

Biserial correlations were computed between the number of errors made on the first four mock tower jumps (taken separately and in combination) and success or failure in the Airborne course. These results are presented in Table 4.

The correlations range from +.27 to +.39. These results indicate that trainees who make more errors on their early jumps from the mock tower are somewhat more likely to fail the Airborne course than trainees who make fewer errors on early mock tower jumps. This relationship, however, is low. It appears that mock tower performance is only one of several aspects of Airborne training and that faulty mock tower performance contributes only a small part to failure on the entire course. In other words, failing more men early in training, on the basis of early mock tower performance, or selecting trainees on this basis, would not lead to material savings because only a few potential failures can be identified in this way.

*Trainees who were temporarily disqualified from Airborne training were not used in this study since it has been found that a fairly large number of trainees who are temporarily disqualified will eventually pass the Airborne course.

TABLE 4

The Relationship between Number of Errors on Early Mock Tower Jumps and Eventual Success or Failure* in the Airborne Course

	Mock Tower Jump Number						
	1	2	3	4	1 and 2 combined	1, 2, and 3 combined	1, 2, 3 and 4 combined
Biserial correlation coefficient between number of errors and pass-fail status**	+.27	+.31	+.36	+.33	+.33	+.39	+.38
Number of Jumpers	1054	1051	1040	1031	1051	1040	1031
Per cent Failed	9%	9%	8%	7%	9%	8%	7%

*For each mock tower jump, the fail group consisted only of trainees who failed the course subsequent to making that particular jump, thus accounting for the decreasing number of jumpers from jump 1 to 4.

**A positive correlation indicates that the more errors a man made, the more likely it was that he would fail. For each correlation the sampling error was .05.

A question then arises concerning the relationship between frequency of initial errors and speed of attaining the criterion of a satisfactory jump. In investigating this, the mock tower records of 65 trainees were used. Trainees who had made at least four mock tower jumps were randomly selected from one Airborne class. The group included persons whose first satisfactory jump occurred anywhere from the first to the twenty-fifth attempt. In order to retain the poorest subjects in the population and prevent curtailment of the data, persons who never achieved a satisfactory jump were arbitrarily considered to have made one on their twenty-eighth attempt.

Correlations were computed between the number of errors on mock tower jumps 1 through 4 (taken separately and in combination) and the number of jumps required by the trainee before he made his first satisfactory jump. (A satisfactory jump is one on which no errors are observed.) The results are shown in Table 5.

The range of correlation was from +.47 to +.70. In view of the attenuation due to observer unreliability, these results indicate a considerable positive relationship between number of mock tower errors and first satisfactory jump. That is, trainees who make more errors on their first four jumps are likely to require more jumps before attaining their first satisfactory jump than those who make fewer errors. The relationship between number of errors on early jumps and first satisfactory mock tower jump is, as expected, greater than that between number of errors on early jumps and eventual pass-fail status for the whole course.

TABLE 5

The Relationship between Number of Errors on Early Mock Tower Jumps and First Satisfactory Jump of 65 Trainees

	Mock Tower Jump Number						
	1	2	3	4	1 and 2 combined	1, 2 and 3 combined	1, 2, 3 and 4 combined
Correlation coefficient between number of errors and first satisfactory jump	+.47	+.62	+.65	+.57	+.65	+.69	+.70
Average number of errors*	3.85	3.17	2.83	2.37	7.02	9.85	12.22
Standard deviation	1.37	1.74	1.71	1.64	2.63	4.08	5.38

*A mean of 9.5 trials was required to make the first satisfactory jump.

From these results it is concluded that the mock tower rating system is fairly satisfactory as a measure of mock tower performance, and as such its use for corrective instruction in this phase of training is justified. Initial mock tower errors should not, however, be thought of as a good indication of eventual success or failure in the Airborne course.

Persistence of Errors in Jump Form

The study of persistence and frequency of the various categories of error required more extensive records than the error rating system allowed. For this reason motion pictures were taken of the first ten mock tower jumps of 35 Airborne trainees who were in training in November, 1952. Two expert raters from the Airborne Department at Fort Benning studied the films at various speeds and arrived at an agreed listing of the errors appearing on each jump.

Since some of the errors on the 31-item list (namely, various hand and force errors) were difficult to distinguish in the films, and since the raters seemed to use the particular errors in these classes interchangeably, some of the analyses to be presented below were done in terms of larger groupings of errors. The symbol designating five or more errors was not used.

The percent of trainees who made each type of error was obtained for each jump. Table 6 presents these data for seven types of errors which accounted for most of the mistakes made. Table 7 lists the errors which were not made by more than 15% of the jumpers on any jump. Three errors on the standard list were not made at all:

TABLE 6

Per Cent of Trainees Making Specified Frequent Errors on a Series of Mock Tower Jumps

	Mock Tower Jump Number									
Type of Error	1	2	3	4	5	6	7	8	9	10
Force Errors*	69%	55%	47%	37%	15%	24%	21%	6%	9%	9%
Hand Errors**	89	97	88	86	76	94	88	91	79	58
Grabbed Reserve in Door	43	27	18	26	9	12	15	12	9	6
Knees Bent	89	85	82	66	56	58	49	39	36	39
Feet Apart	86	85	76	60	50	36	33	27	27	24
Head Up	77	88	82	74	52	70	52	48	36	39
Elbows Out	86	76	74	63	76	82	58	52	52	39
Number of Jumpers***	35	33	34	35	34	33	33	33	33	33

*Force errors (low force of exit from the mock tower) consists of: squat out, fall out, and weak exit.

**Hand errors consist of: hands crossed over reserve parachute, arms crossed over reserve, hands on top of reserve, and hands crossed on top of reserve.

***The number of jumpers varies over jumps 1-10 due to the lack of clarity in parts of the film, and the elimination of one trainee on the fifth jump and another on the sixth jump for refusal to jump from the mock tower.

TABLE 7

Per Cent of Trainees Making Specified Infrequent Errors on a Series of Mock Tower Jumps

	Mock Tower Jump Number									
Type of Error	1	2	3	4	5	6	7	8	9	10
Dive Out	0%	6%	6%	3%	0%	0%	0%	0%	0%	0%
Kick Out	11	12	9	6	6	12	6	3	6	3
Recover too Quickly	0	3	0	0	0	3	3	3	3	3
Both Feet in Door	9	6	9	9	15	15	3	9	3	0
Turn in Air	6	3	0	6	6	6	3	12	6	3
Hesitate	11	3	6	3	0	0	3	0	3	0
Reaction Poor	3	3	0	3	0	0	0	0	0	0
Body Straight	0	0	0	0	0	0	3	0	0	3
Number of Jumpers*	35	33	34	35	34	33	33	33	33	33

*The number of jumpers varies over jumps 1-10 due to the lack of clarity in parts of the film, and the elimination of one trainee on the fifth jump and another on the sixth jump for refusal to jump from the mock tower.

"wrong foot in the door," "bent at the waist," and "stepped out."*

With practice some errors disappeared sooner than others. "Force errors" decreased most rapidly during the ten trials, making the largest over-all drop. "Hand errors," in contrast, seemed to be most difficult to eradicate. By the tenth trial a sizable proportion of the group. (about one-third) still were jumping with "knees bent," "feet apart," "head up," or "elbows out," although steady decreases had occurred in the numbers of these errors. The pattern of error reduction was similar for these last four types. Figure 1 shows the course of reduction of some of the more frequently observed errors.

The above findings on persistence of errors can only be regarded as suggestive, because of the small and possibly non-representative nature of the group of trainees studied.** In addition, there were no data for those errors which could not be scored from the films. There is, however, strong indication that since about seven types of error account for the majority of errors seen, more emphasis in training and corrective instruction might appropriately be placed upon these errors. Such a judgment, however, must take into account the seriousness of each type of error, a subject on which there is yet little evidence. It may also prove desirable to shorten the present rating

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*Data were not obtained for three errors which could not be scored from the films: jumping with eyes closed, making an exit prior to being tapped, and improper counting prior to jumping.

**Appendix D gives additional information on errors in the Airborne rating system. This information is based on the actual ratings made at the mock tower of several hundred jumpers going through training during the fall of 1952. Although there is less certainty of the reliability of these ratings compared to the film ratings, the results confirm the relatively infrequent use of many of the errors in the standard rating list.

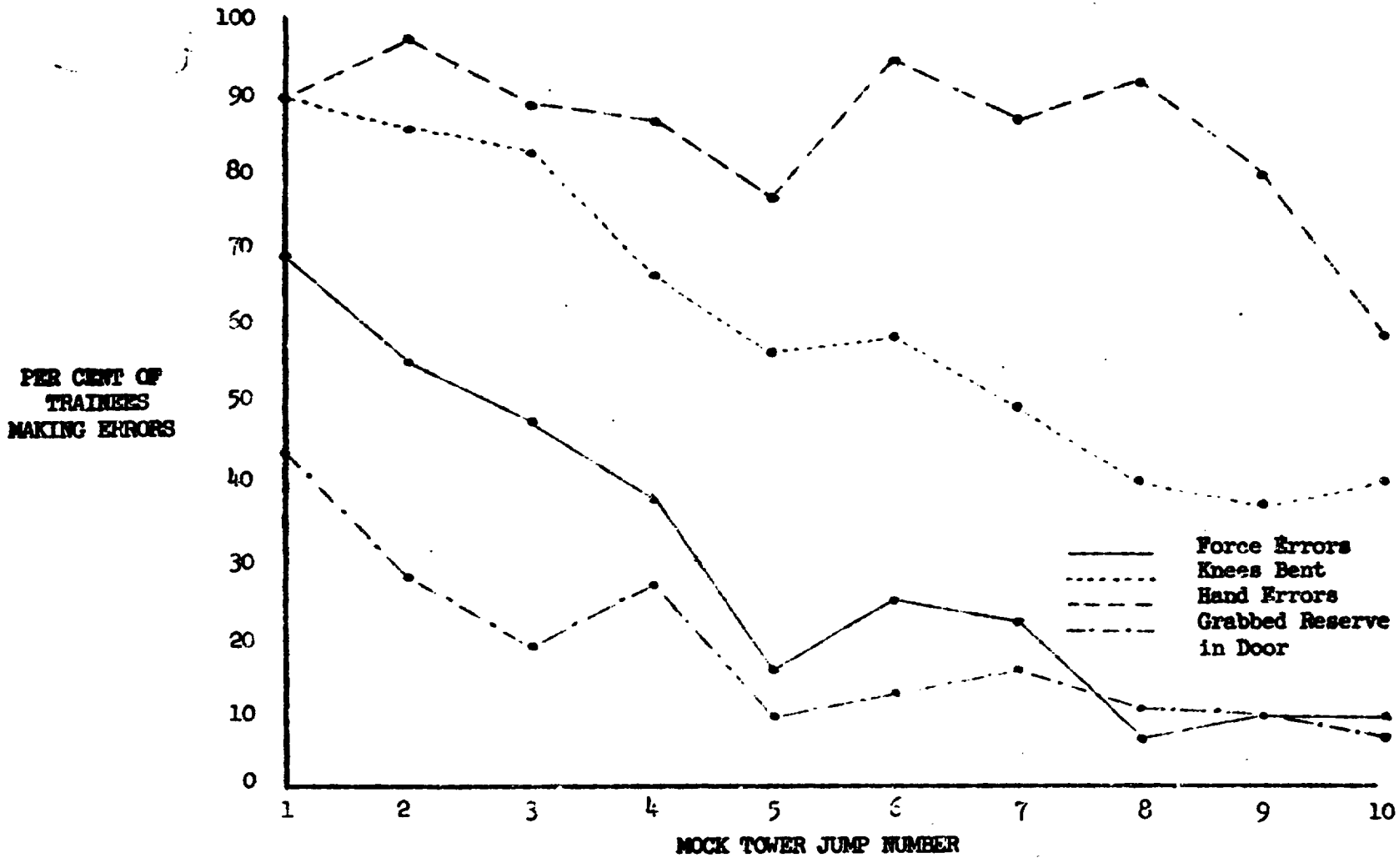

Fig. 1. Per Cent of Trainees Making Specified Errors on the First Ten Mock Tower Jumps.

system by excluding those existing error symbols which very rarely appear in the ratings of trainee jumps; this would probably increase accuracy of observation on the part of the rater.

APPENDIX A

Analysis of Variance for 8 Raters on a Series of Mock Tower Jumps (Trials 1, 3, 5, 7 and 9 Combined)

Component	df	Mean Square
Between Raters	7	27.02
Within Groups	2236	3.34
Total	2243	

$F = 8.09, \quad P > .01$

APPENDIX B

Agreement among Eight Raters* on Frequency of Errors Expressed on 106 First Mock Tower Jumps in Terms of Pearson Product-Moment Correlations***

Rater	2	3	4	5	6	7	8
1	.82	.77	.74	.85	.68	.82	.81
2		.77	.76	.82	.67	.76	.77
3			.68	.82	.71	.75	.73
4				.77	.65	.70	.80
5					.67	.79	.83
6						.65	.63
7							.72

*Neither the raters nor the trainees studied are the same as those studied in the first part of this report.

**Average correlation = .78.

APPENDIX C

Mean and Standard Deviations f Error Ratings for Eight Raters on 106 First Mock Tower Jumps (The "Artificial" Situation)

	Rater							
	1	2	3	4	5	6	7	8
Mean Number of Errors	3.5	3.3	3.3	3.5	2.9	3.7	3.5	3.6
Standard Deviations	1.3	1.5	1.4	1.4	1.5	1.4	1.4	1.4

Analysis of Variance for 8 Raters on 106 First Mock Tower Jumps (The "Artificial" Situation)

Component	df	Mean Square	F
Between raters	7	5.84	11.38*
Between jumpers	105	12.50	24.37*
Interaction	735	.51	
Total	847		

*Significant at the .01 level

APPENDIX D

Per Cent of Trainees Making Specified Errors on a Series of Mock Tower Jumps

(Actual Ratings Made at the Mock Tower)

	Mock Tower Jump Number					
Errors*	1	2	3	4	8	10
(X) 4 or More Errors	50%	38%	27%	19%	7%	6%
Hand Errors	24	34	41	43	37	31
Force Errors	38	30	27	22	16	9
Head Up	27	31	52	30	21	13
Knees Bent	14	20	21	20	16	14
Feet Apart	21	19	16	17	10	8
Grabbed Reserve in Door	11	11	7	8	5	3
Elbows Out	6	8	7	6	6	8
No Count	8	7	7	6	3	1
Late Count	3	4	5	6	4	3
Turn in Air	3	4	3	2	2	2
Both Feet in Door	3	3	4	4	4	2
Eyes Closed	4	4	3	3	3	2
Dive Out	4	4	4	3	1	1
Wrong Count	3	5	5	4	2	1
Reaction Poor	3	2	3	3	3	2
No Tap	3	4	3	2	1	1
Body Straight	3	4	4	2	1	0
Kick Out	1	2	2	2	2	1
Step Out	2	3	3	2	1	1
Fast Count	0	1	0	1	1	0
Wrong Foot in Door	0	0	0	0	0	0
Recover Too Quickly	1	1	1	1	2	1
Bent at Waist	0	0	0	0	0	0
Count in Door	0	0	0	0	0	0
Number of Jumpers**	1737	1732	1718	1702	1669	1475

*The percentages in this table are not comparable to those in Table 5 and 6 since the (X) symbol, used in the actual ratings but not in the film ratings, subsumes all other errors made without listing them individually.

**The number of jumpers decreases over jumps due to the fact that some trainees were disqualified from training during the first 10 mock tower jumps.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) THE MOCK TOWER RATING SYSTEM IN THE AIRBORNE TRAINING PROGRAM		5. TYPE OF REPORT & PERIOD COVERED Staff Memorandum 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Gerald Kent, Charles Windle, and Howard H. McFann		8. CONTRACT OR GRANT NUMBER(s) DA 44-109-qm-650
9. PERFORMING ORGANIZATION NAME AND ADDRESS Human Resources Research Organization (HumRRO) 300 North Washington Street Alexandria, Virginia 22314		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Dept. of the Army Office, Chief of Army Field Forces		12. REPORT DATE February 1954 13. NUMBER OF PAGES 22
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

This research was begun at Fort Benning, Georgia, by a Task Force of the Human Resources Research Office of the George Washington University, and completed by Human Research Unit No. 3, Office of the Chief of Army Field Forces under Project JUMPRATING.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Mock Tower
Airborne Training Program
Attrition Rate

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Before actual use of a parachute, Airborne trainees make a number of jumps from a 34-foot mock tower designed to simulate the conditions of free fall and riser shock. This training is intended to teach the proper method of exit from the plane door and the correct body position during free fall. In the course of study of methods to decrease the attrition rate in Airborne training, the mock tower phase of training has come under surveillance. In particular, this report is concerned with technical evaluation of the

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20. Continued...

reliability and validity of the mock tower rating system, the primary measuring device used in corrective instruction and grading performance during this phase of training.